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Open Fiber Control for Parallel Optics

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Open Fiber Control History

- The concept of using open fiber control has been used in the telecom industry for some time, mostly in Europe.
- During the development of the first optical link standard using CD type lasers, the issue of laser safety in an uncontrolled user environment was raised.
- IBM worked diligently with laser safety experts on a worldwide basis resulting in the development of FC-PH's OFC control.
- IEC 825-2 authorizes the concept of OFC to achieve IEC 825 class 1 eye safety

FC-PH Open Fiber Control (OFC)

- Documented in ANSI X3.230-1994 section 6.2.3 pp 42-48.

- Basic Concept -
  - Normally no light is emitted so link is safe.
  - If fiber breaks or connector is removed, the transmitter must reduce power level to class 1 eye safety.
  - Upon fiber connection being established - verify connection and power up laser to normal operating level.
  - IEC-825 requires class 1 in event of single fault failure so must have robust algorithm and redundancy in circuits.
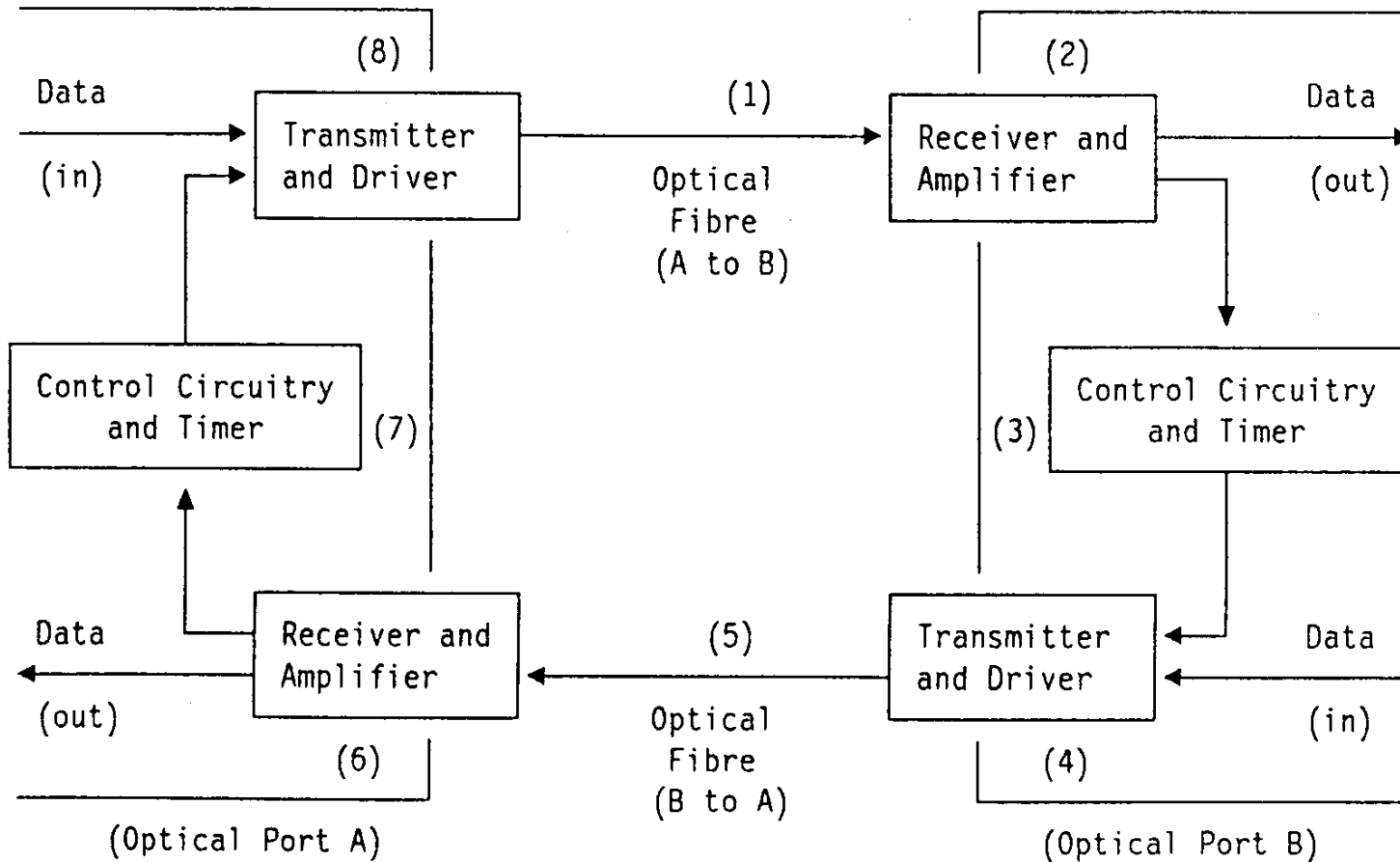
Typical Link

Figure 23 - Block diagram of the OFC safety system

OFC -- link management using a state machine

- Use an on-off-on algorithm
- Four states to the state machine
- Active - normal operation; if LOL signal asserts move immediately to disconnect state.
- Disconnect - maintains class 1 light output; for FC-PH issues a short light pulse, called decode one, every T sec. Stays in this state until LOL is deasserted and an optical signal is both sent and received during a decode 1 period.
- Stop - entered from disconnect state - power down laser and ensure that LOL is asserted within decode 2 period.
- Reconnect - another send/ receive sequence and transfer to active

FC-PH state machine
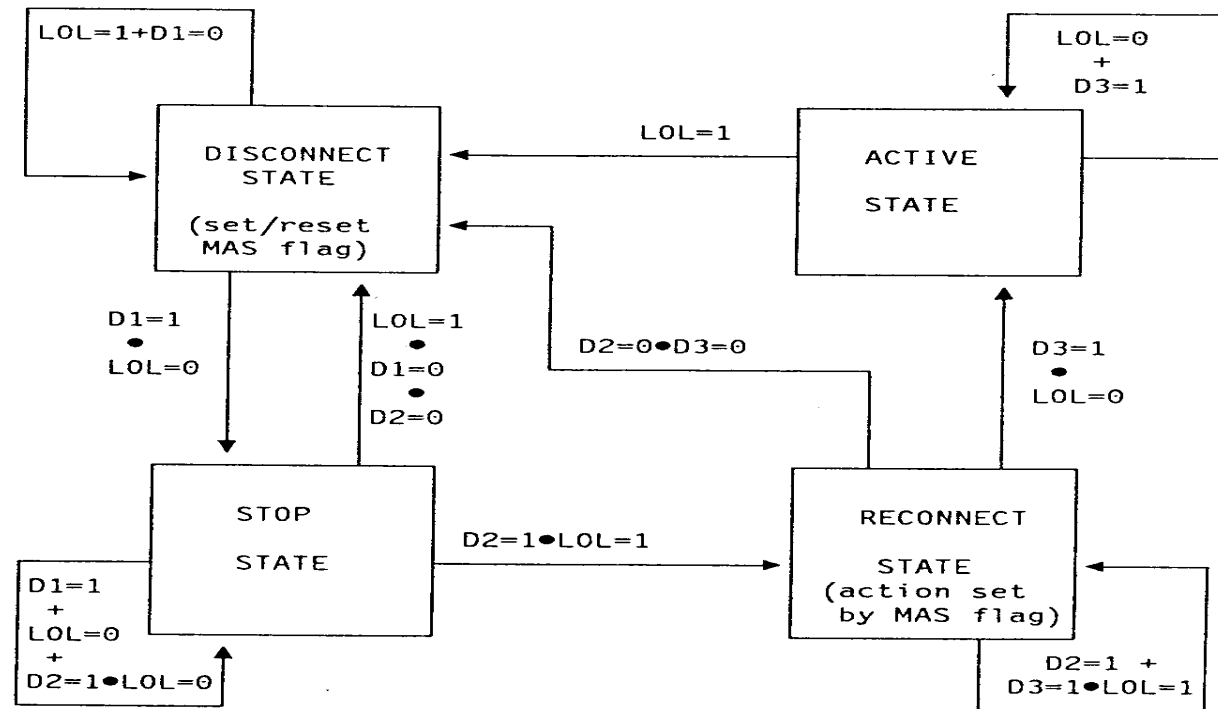
DEFINITIONS:
LOL = Loss of light flag (asserted = 1, deasserted = 0)
MAS = Master of link reconnection flag
D1 = Decode 1 - 1st time period flag = Link check
D2 = Decode 2 - 2nd time period flag = Disable laser
D3 = Decode 3 - 3rd time period flag = Link check

Figure 24 - Open Fibre Control module State Diagram
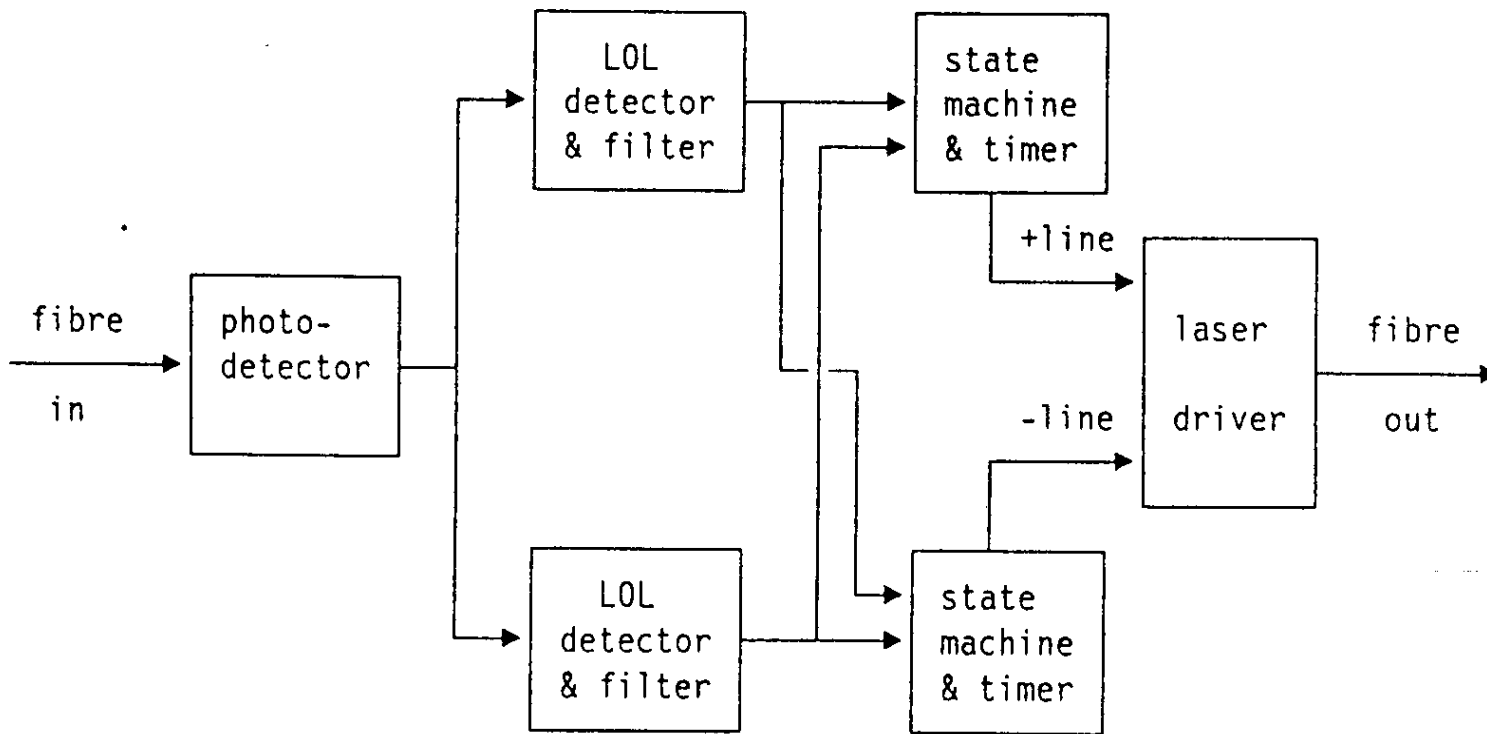
Redundancy Needed

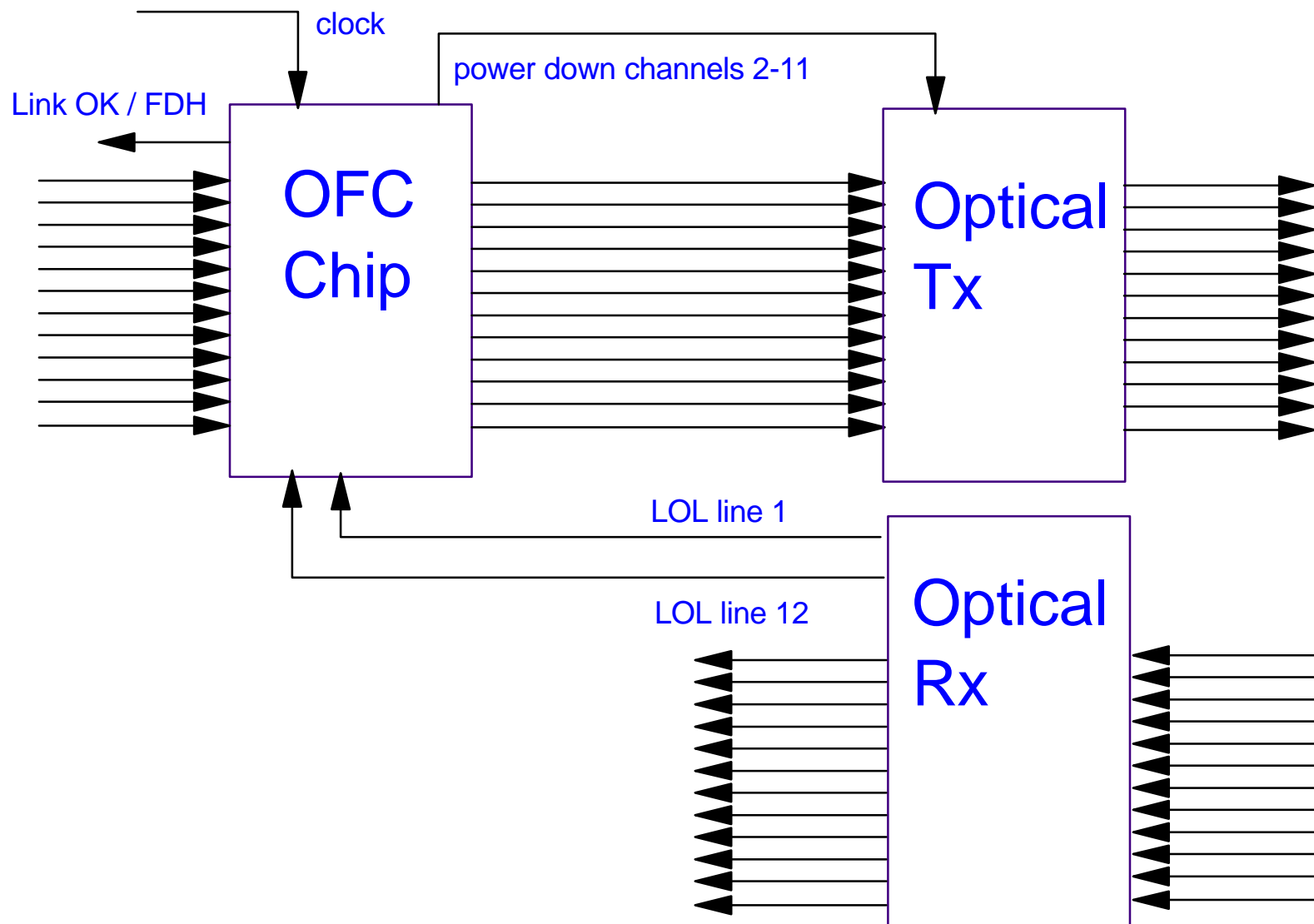Figure 25 - Block diagram of the OFC safety redundancy

OFC for parallel optics?

- Very difficult to achieve class 1 eye safety for parallel optics due to 12 transmit fibers being 250um apart in an MT ferrule. The light adds from near neighbor fibers in the eye safety calculation.
- BUT - light from location 1 and location 12 due not add.
- Can this be used to implement a simple redundant OFC circuit?

OFC proposal

- If only channel one and/or channel 12 are powered then link is eye safe to class one if each individual channel is eye safe.
- No need to make short pulses to insure eye safety.
- Signal detect or LOL will be needed for both channel one and channel 12.

Parallel Optical Link

clock

power down channels 2-11

Link OK / FDH

OFC Chip

Optical Tx

LOL line 1

LOL line 12

Optical Rx

Parallel Optics State machine

-                     LOL1   LOL12

	LOL1	LOL12
Active	0	0
Disconnect	1	1
Stop	0	1
Reconnect	1	0

OFC for parallel optics state machine description

- Active to Disconnect when either LOL1 or LOL12 asserts
- Disconnect state - channel one transmits clock and looks for LOL1 to deassert. Channels 2-11 are powered down and lines are held in light low logic level. Channel 12 is held in light low logic level and LOL 12 must be in assert mode. Upon all conditions met, moves to stop state.
- Stop - powers down channel 1 and transmits clock on channel 12. LOL 1 asserts and LOL 12 deasserts before NN transitions of clock.
- After sucessful Stop - move to Active

Is Proposal Failsafe?

- Is this robust?
- Can you connect Tx and Rx to separate nodes and still power up?
- Is their enough redundancy?

- Are channel 1 and 12 operating together eye safe.
  What is the margin?
  Can we relieve the NA control requirement?